US009457369B2

(12) **United States Patent**
Kim

(10) **Patent No.: US 9,457,369 B2**
(45) **Date of Patent: Oct. 4, 2016**

(54) **ORGANIC LIGHT-EMITTING DISPLAY APPARATUS AND DEPOSITION MASK FOR THE APPARATUS**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/661,005**

(22) Filed: **Mar. 18, 2015**

(65) **Prior Publication Data**

US 2016/0093834 A1 Mar. 31, 2016

(30) **Foreign Application Priority Data**

Sep. 29, 2014 (KR) 10-2014-0130338

(51) **Int. Cl.**
B05B 15/04 (2006.01)
H01L 27/32 (2006.01)

(52) **U.S. Cl.**
CPC ***B05B 15/045*** (2013.01); ***H01L 27/3218*** (2013.01); ***H01L 27/3223*** (2013.01)

(58) **Field of Classification Search**
CPC H01L 51/56
See application file for complete search history.

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(57) **ABSTRACT**

An organic light-emitting display apparatus including: a substrate including a light emission area and a non-emission area disposed in an outer portion adjacent the light emission area; a plurality of subpixels disposed in the light emission area of the substrate and including a first electrode, a emission layer, and a second electrode, wherein the plurality of subpixels respectively emit light of different colors; and a plurality of dummy emission layers that are disposed in a non-emission area of the substrate and are of different colors. A first distance between adjacent dummy emission layers of a first color, from among the plurality of dummy emission layers is smaller than a second distance between adjacent subpixels that emit light of the first color, from among the plurality of subpixels.

15 Claims, 8 Drawing Sheets

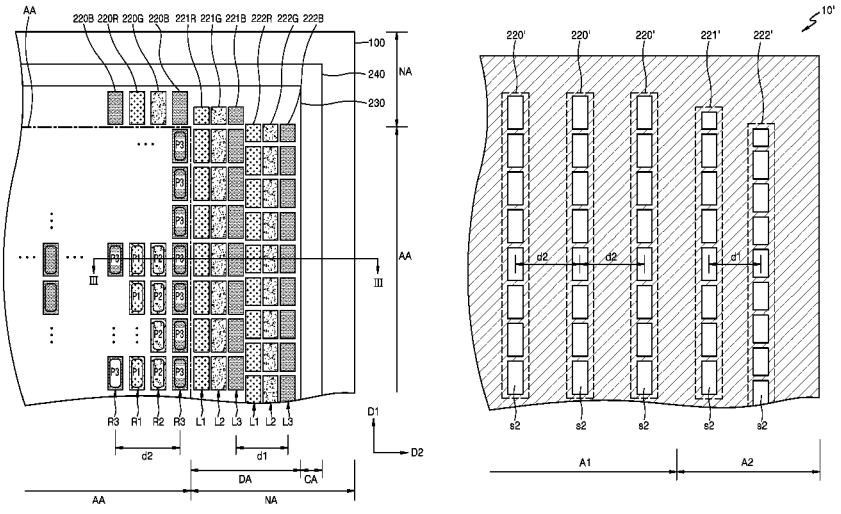


FIG. 1

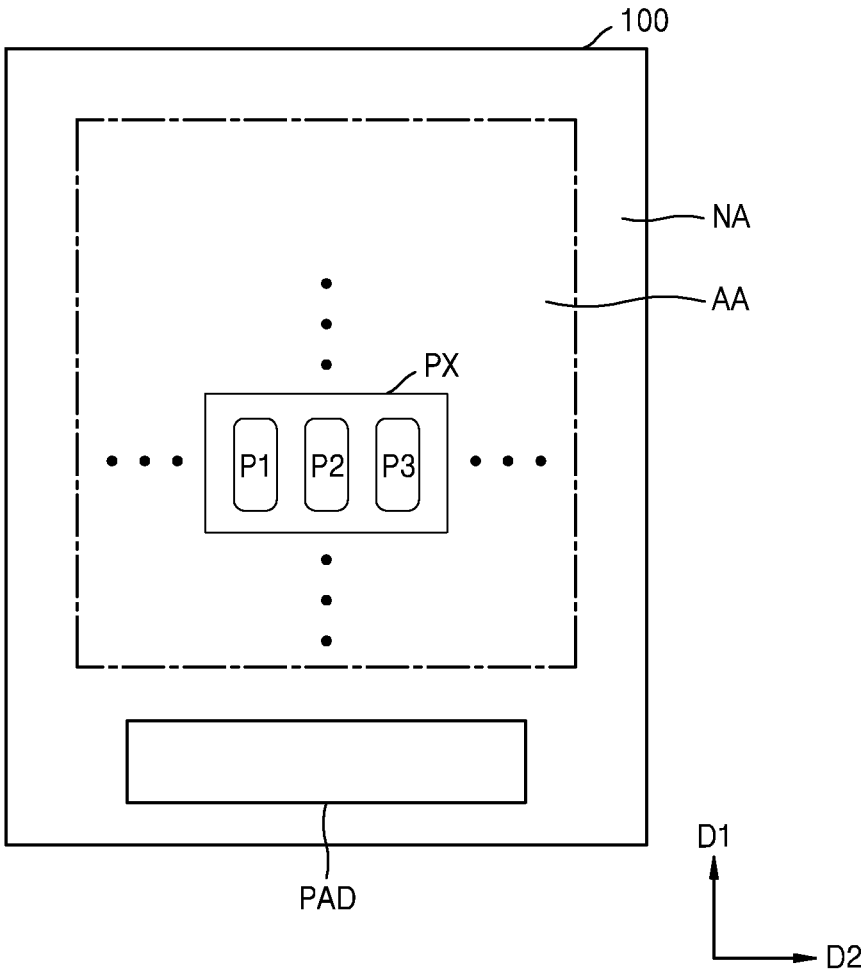


FIG. 2A

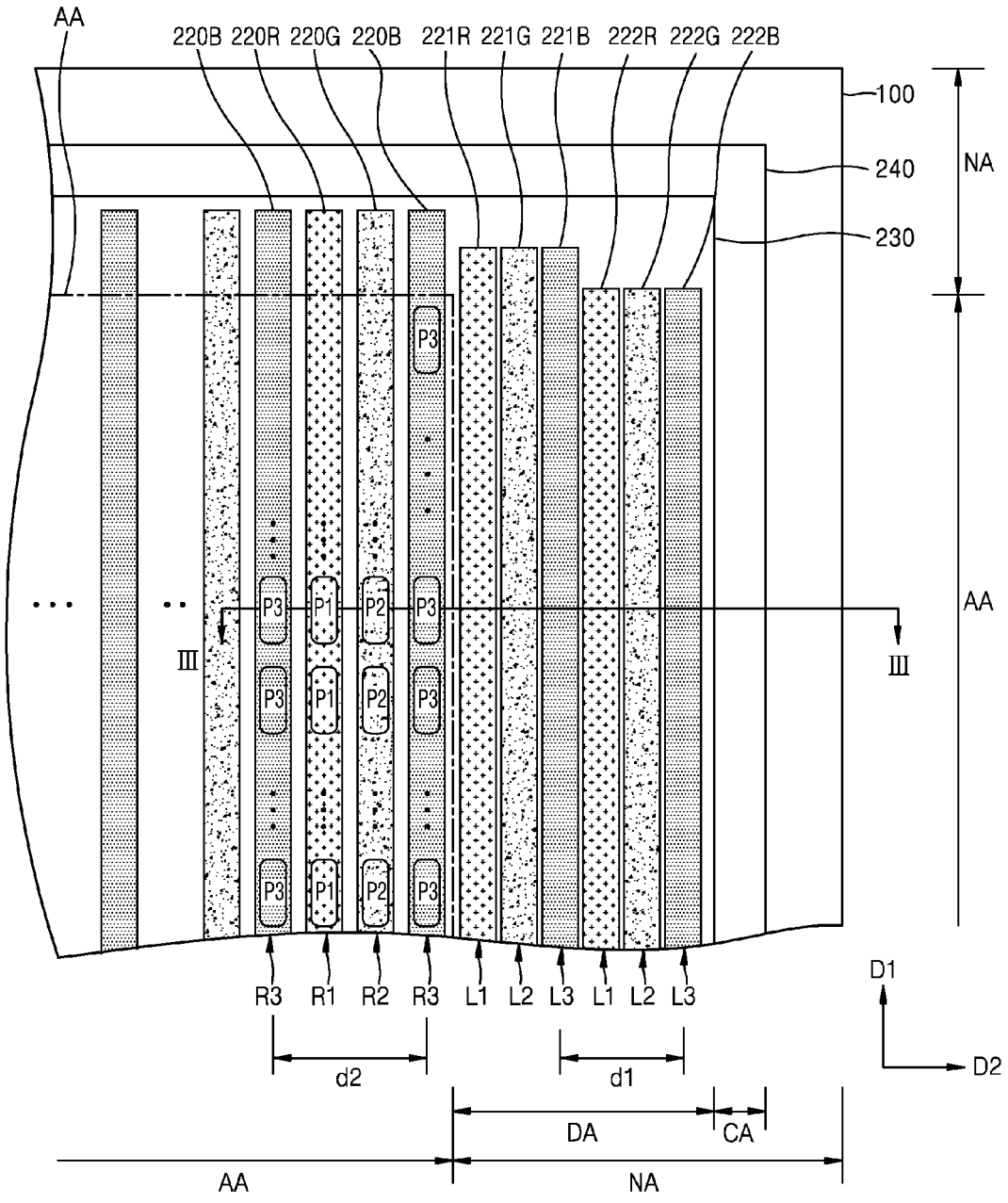

AA
220B 220R 220G 220B 221R 221G 221B 222R 222G 222B
100
240
230
NA
AA
III
III
P3
P1
P2
R3 R1 R2 R3 L1 L2 L3 L1 L2 L3
d2
d1
DA
CA
AA
NA
D1
D2

FIG. 2B

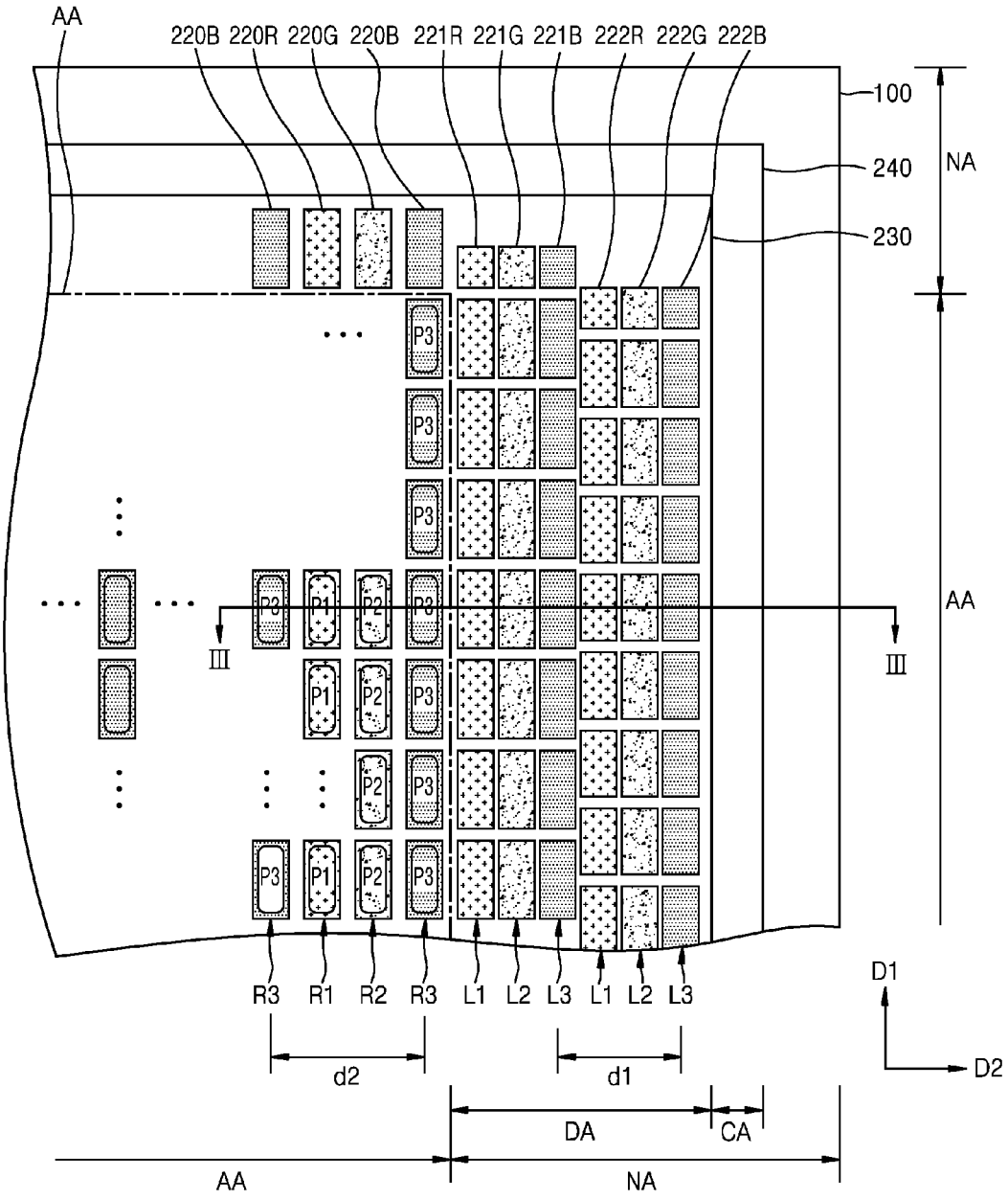

AA
220B 220R 220G 220B 221R 221G 221B 222R 222G 222B
100
240
230
NA
AA
III
III
P3
P1
P2
R3 R1 R2 R3 L1 L2 L3 L1 L2 L3
d2
d1
DA
CA
AA
NA
D1
D2

FIG. 3

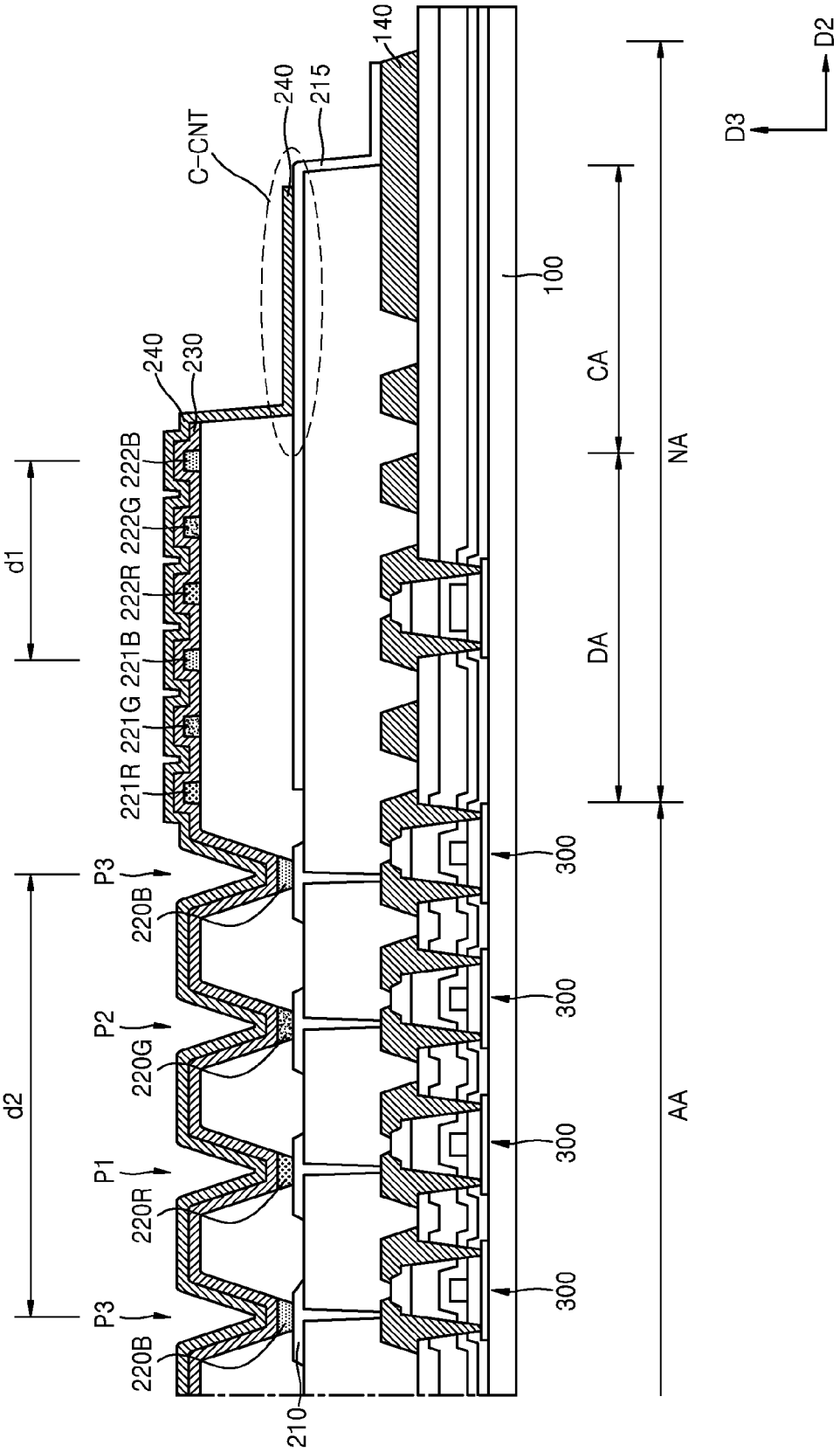

140
240
215
C-CNT
100
240
230
222B
222G
222R
221B
221G
221R
d1
d2
P3
220B
P2
220G
P1
220R
P3
220B
210
300
300
300
300
CA
DA
NA
AA
D3
D2

FIG. 4a

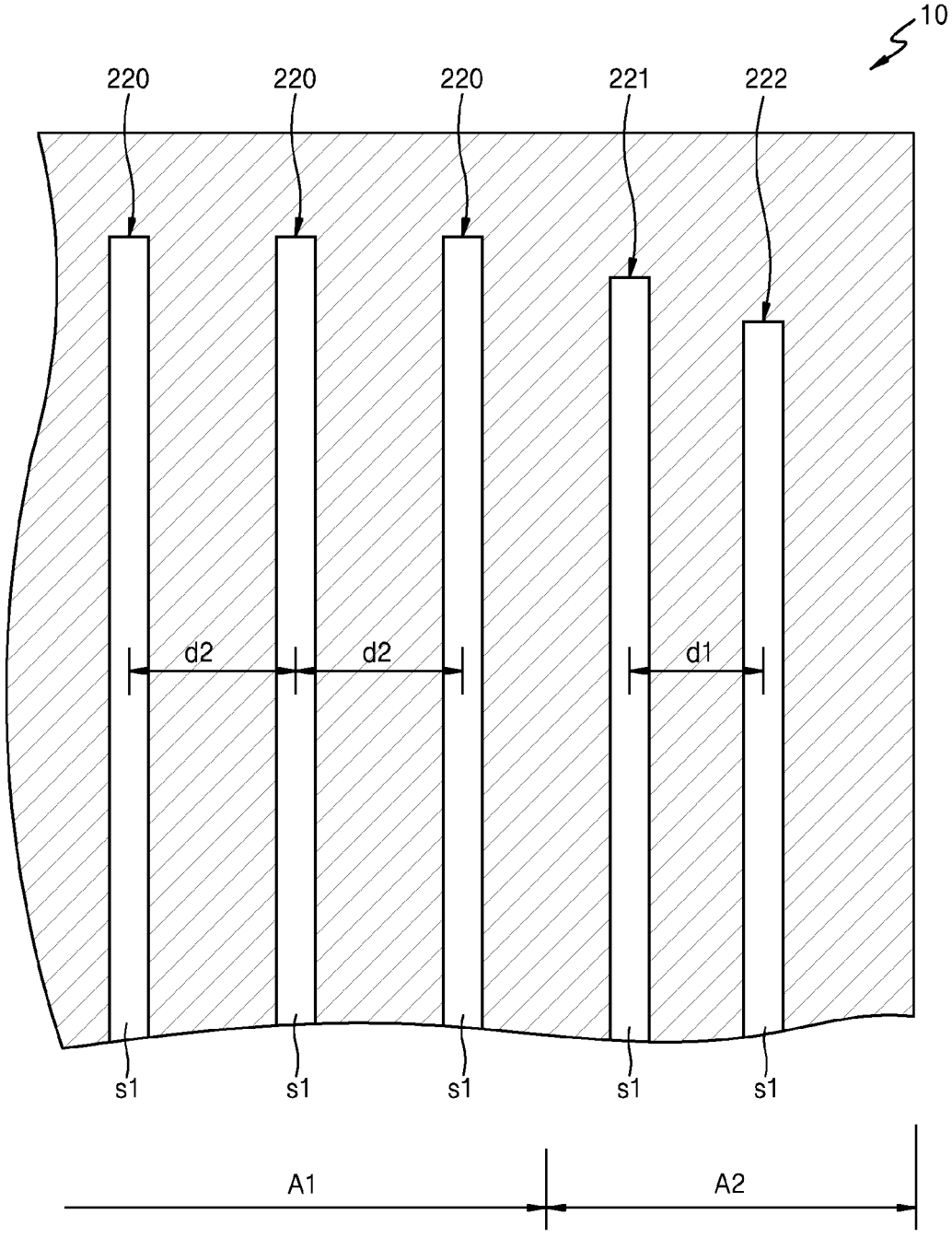


FIG. 4b

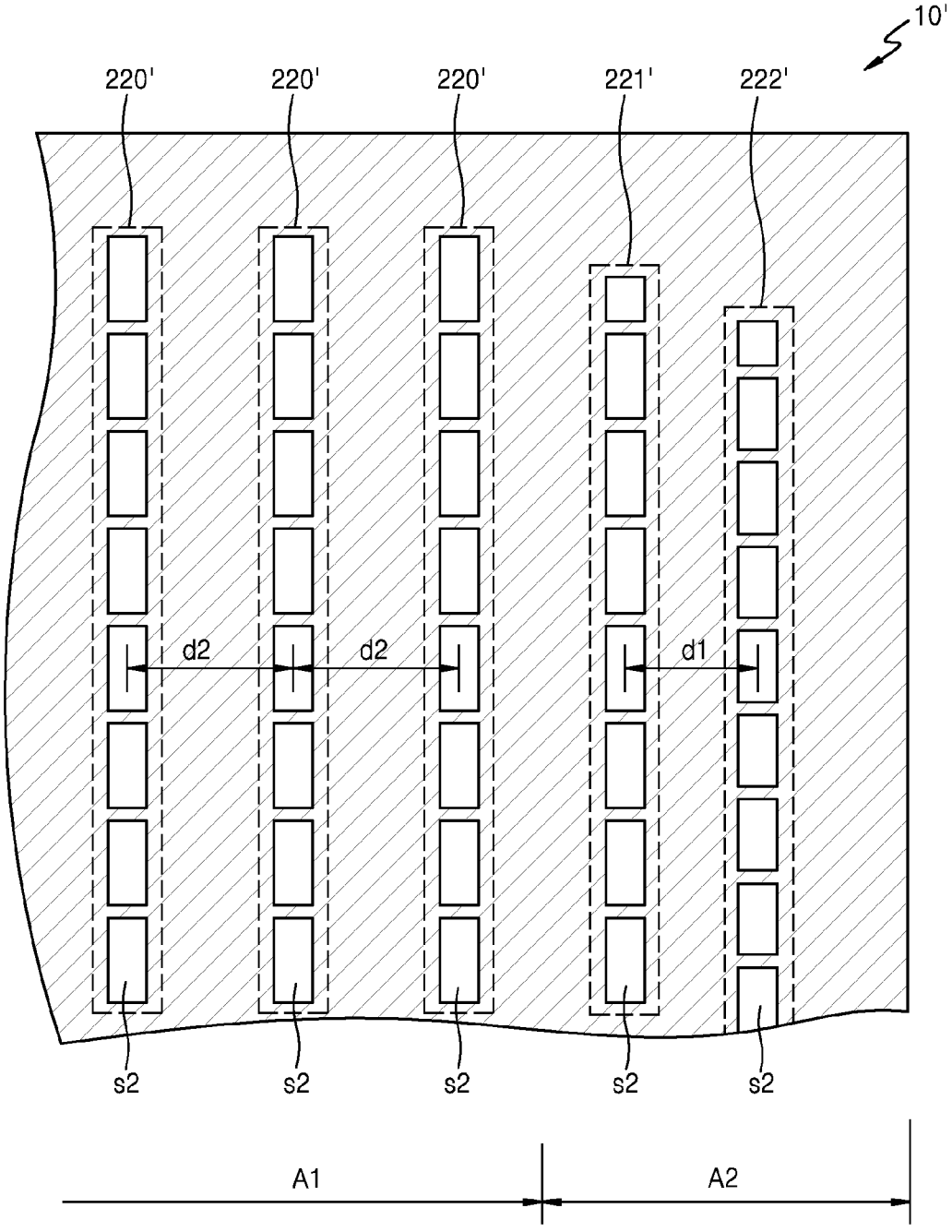


FIG. 5

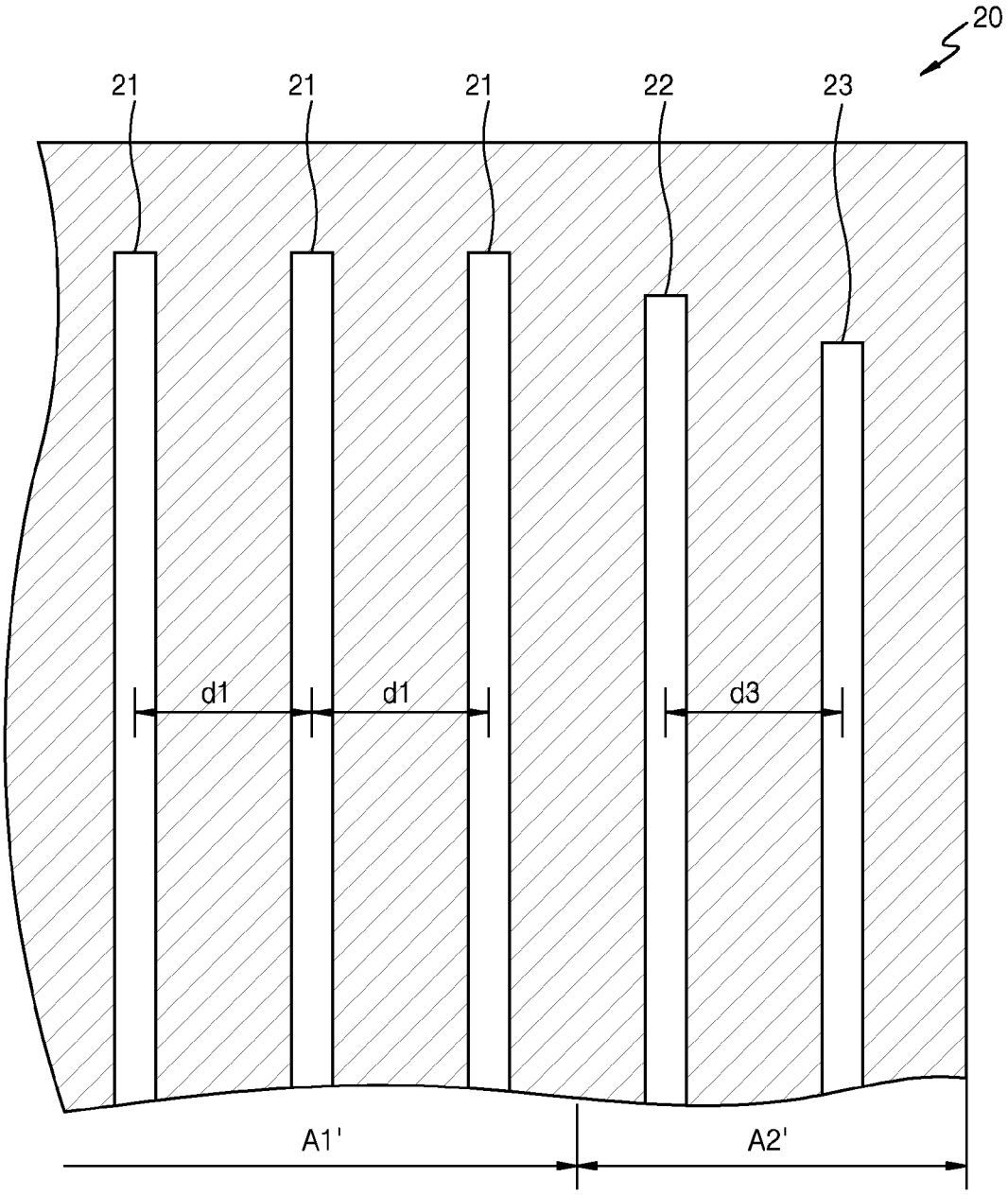
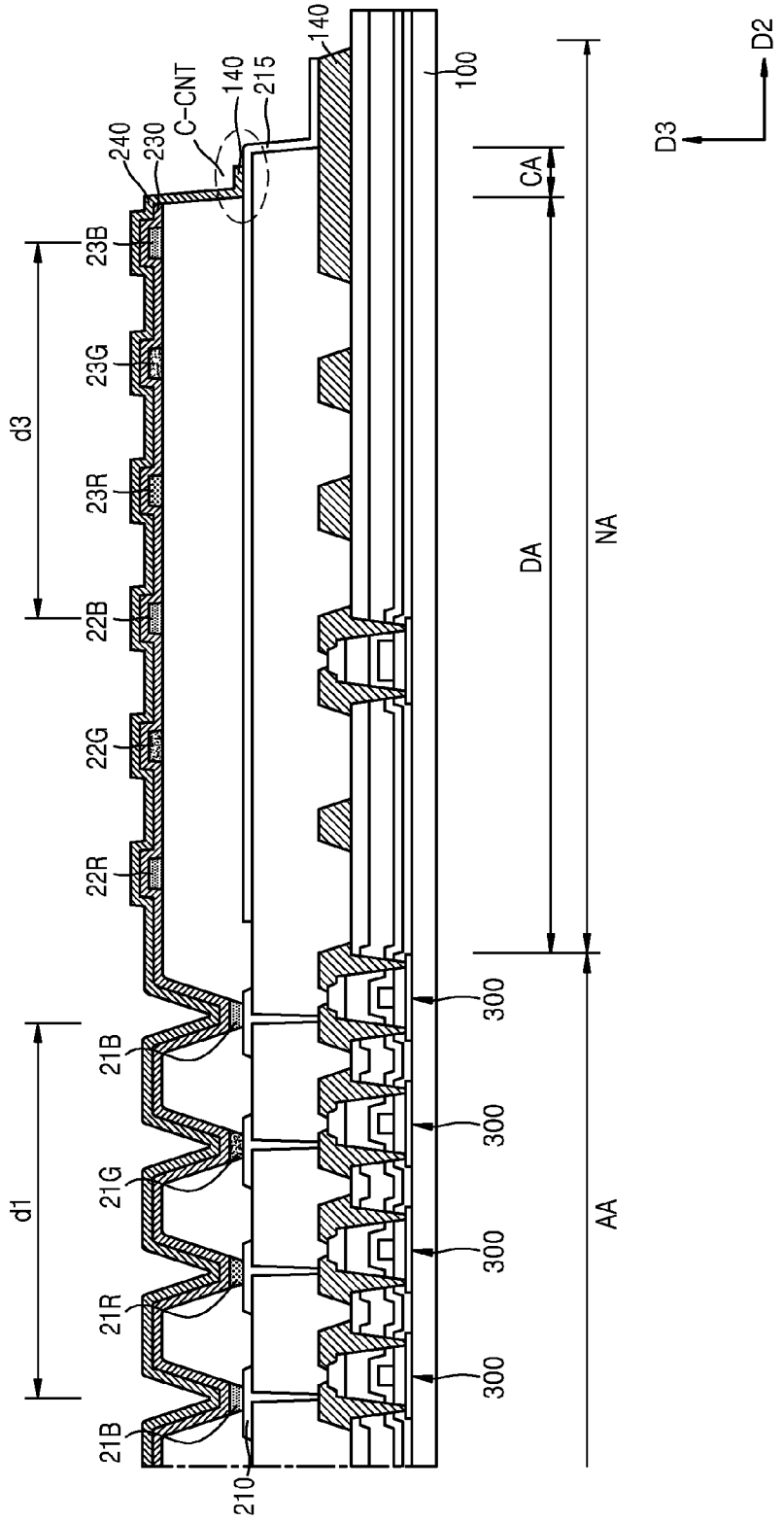


FIG. 6


140
100
D2
D3
C-CNT
140
215
240
230
CA
23B
23G
23R
d3
22B
22G
22R
DA
NA
21B
21G
21R
21B
d1
300
300
300
300
AA
210

ORGANIC LIGHT-EMITTING DISPLAY APPARATUS AND DEPOSITION MASK FOR THE APPARATUS

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority from and the benefit of Korean Patent Application No. 10-2014-0130338, filed on Sep. 29, 2014, which is hereby incorporated by reference for all purposes as if fully set forth herein.

BACKGROUND

1. Field

Exemplary embodiments relate to an organic light-emitting display apparatus and a deposition mask for the organic light-emitting display apparatus.

2. Discussion of the Background

A display apparatus is an apparatus for displaying an image, and recently, an organic light-emitting diode display has been used as a display apparatus.

An organic light-emitting display apparatus is self-emissive, and does not require an additional light source, unlike a liquid crystal display device. Thus, an organic light-emitting display apparatus may advantageously be thin and lightweight. In addition, an organic light-emitting display device has beneficial qualities, such as low power consumption, high luminance, and a high response speed.

In order to manufacture a full-color organic light-emitting display device, a technique of depositing a red (R) emission layer, a green (G) emission layer, and a blue (B) emission layer independent of one another on a substrate by using a deposition mask may be used.

The above information disclosed in this Background section is only for enhancement of understanding of the background of the inventive concept, and, therefore, it may contain information that does not form the prior art that is already known in this country to a person of ordinary skill in the art.

SUMMARY

Exemplary embodiments provide an organic light-emitting display apparatus and a deposition mask for the organic light-emitting display apparatus.

Additional aspects will be set forth in part in the description which follows and, in part, will be apparent from the disclosure, or may be learned by practice of the inventive concept.

An exemplary embodiment of the present invention discloses an organic light-emitting display apparatus including: a substrate including a light emission area and a non-emission area disposed in an outer portion adjacent the light emission area; a plurality of subpixels disposed in the light emission area of the substrate and including a first electrode, an emission layer, and a second electrode, wherein the plurality of subpixels are configured to respectively emit light of different colors; and a plurality of dummy emission layers that are disposed in the non-emission area of the substrate and are of different colors. A first distance between adjacent dummy emission layers of a first color, from among the plurality of dummy emission layers, is smaller than a second distance between adjacent subpixels that emit light of the first color, from among the plurality of subpixels.

An exemplary embodiment of the present invention also discloses a deposition mask for manufacturing an organic light-emitting display apparatus including: a plurality of effective opening portions that correspond to a light emission area and are disposed in parallel to one another; and a plurality of dummy opening portions that correspond to a non-emission area included in an outer portion adjacent the light emission area and that are disposed in parallel to one another. A first distance between adjacent dummy opening portions from among the dummy opening portions is smaller than a second distance between adjacent effective opening portions from among the effective opening portions.

These general and specific embodiments may be implemented by using a system, a method, a computer program, or a combination of the system, the method, and the computer program.

The foregoing general description and the following detailed description are exemplary and explanatory and are intended to provide further explanation of the claimed subject matter.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are included to provide a further understanding of the inventive concept, and are incorporated in and constitute a part of this specification, illustrate exemplary embodiments of the inventive concept, and, together with the description, serve to explain principles of the inventive concept.

FIG. **1** is a plan view schematically illustrating an organic light-emitting display apparatus according to an exemplary embodiment.

FIG. **2**A is a plan view illustrating a portion of an organic light-emitting display apparatus according to an exemplary embodiment.

FIG. **2**B is a plan view illustrating a portion of an organic light-emitting display apparatus according to another exemplary embodiment.

FIG. **3** is a cross-sectional view of the organic light-emitting display apparatus cut along a line III-III of FIGS. **2**A and **2**B.

FIG. **4**A is a plan view illustrating a portion of a deposition mask for an organic light-emitting display apparatus according to an exemplary embodiment.

FIG. **4**B is a plan view illustrating a portion of a deposition mask for an organic light-emitting display apparatus according to another exemplary embodiment.

FIG. **5** is a plan view illustrating a portion of a deposition mask for an organic light-emitting display apparatus according to a comparative example.

FIG. **6** is a cross-sectional view illustrating an organic light-emitting display apparatus according to a comparative example.

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

In the following description, for the purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of various exemplary embodiments. It is apparent, however, that various exemplary embodiments may be practiced without these specific details or with one or more equivalent arrangements. In other instances, well-known structures and devices are shown in block diagram form in order to avoid unnecessarily obscuring various exemplary embodiments.

In the accompanying figures, the size and relative sizes of layers, films, panels, regions, etc., may be exaggerated for clarity and descriptive purposes. Also, like reference numerals denote like elements.

When an element or layer is referred to as being "on," "connected to," or "coupled to" another element or layer, it may be directly on, connected to, or coupled to the other element or layer or intervening elements or layers may be present. When, however, an element or layer is referred to as being "directly on," "directly connected to," or "directly coupled to" another element or layer, there are no intervening elements or layers present. For the purposes of this disclosure, "at least one of X, Y, and Z" and "at least one selected from the group consisting of X, Y, and Z" may be construed as X only, Y only, Z only, or any combination of two or more of X, Y, and Z, such as, for instance, XYZ, XYY, YZ, and ZZ. Like numbers refer to like elements throughout. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items.

Although the terms first, second, etc. may be used herein to describe various elements, components, regions, layers, and/or sections, these elements, components, regions, layers, and/or sections should not be limited by these terms. These terms are used to distinguish one element, component, region, layer, and/or section from another element, component, region, layer, and/or section. Thus, a first element, component, region, layer, and/or section discussed below could be termed a second element, component, region, layer, and/or section without departing from the teachings of the present disclosure.

As used herein, the term "color" in reference to an emission layer or subpixel refers to the color emitted upon activation, not the color of the material itself. Thus, for dummy emission layers, "color" refers to the color that would be emitted if the material of the dummy emission layer were part of an activated subpixel.

Spatially relative terms, such as "beneath," "below," "lower," "above," "upper," and the like, may be used herein for descriptive purposes, and, thereby, to describe one element or feature's relationship to another element(s) or feature(s) as illustrated in the drawings. Spatially relative terms are intended to encompass different orientations of an apparatus in use, operation, and/or manufacture in addition to the orientation depicted in the drawings. For example, if the apparatus in the drawings is turned over, elements described as "below" or "beneath" other elements or features would then be oriented "above" the other elements or features. Thus, the exemplary term "below" can encompass both an orientation of above and below. Furthermore, the apparatus may be otherwise oriented (e.g., rotated 90 degrees or at other orientations), and, as such, the spatially relative descriptors used herein interpreted accordingly.

The terminology used herein is for the purpose of describing particular embodiments and is not intended to be limiting. As used herein, the singular forms, "a," "an," and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. Moreover, the terms "comprises," comprising," "includes," and/or "including," when used in this specification, specify the presence of stated features, integers, steps, operations, elements, components, and/or groups thereof, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

Various exemplary embodiments are described herein with reference to sectional illustrations that are schematic illustrations of idealized exemplary embodiments and/or intermediate structures. As such, variations from the shapes of the illustrations as a result, for example, of manufacturing techniques and/or tolerances, are to be expected. Thus, exemplary embodiments disclosed herein should not be construed as limited to the particular illustrated shapes of regions, but are to include deviations in shapes that result from, for instance, manufacturing. For example, an implanted region illustrated as a rectangle will, typically, have rounded or curved features and/or a gradient of implant concentration at its edges rather than a binary change from implanted to non-implanted region. Likewise, a buried region formed by implantation may result in some implantation in the region between the buried region and the surface through which the implantation takes place. Thus, the regions illustrated in the drawings are schematic in nature and their shapes are not intended to illustrate the actual shape of a region of a device and are not intended to be limiting.

Unless otherwise defined, all terms (including technical and scientific terms) used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this disclosure is a part. Terms, such as those defined in commonly used dictionaries, should be interpreted as having a meaning that is consistent with their meaning in the context of the relevant art and will not be interpreted in an idealized or overly formal sense, unless expressly so defined herein.

It will be understood that when a layer, region, or component is referred to as being "formed on" another layer, region, or component, it can be directly or indirectly formed on the other layer, region, or component. That is, for example, intervening layers, regions, or components may be present.

Sizes of elements in the drawings may be exaggerated for convenience of explanation. In other words, since sizes and thicknesses of components in the drawings are arbitrarily illustrated for convenience of explanation, the following embodiments are not limited thereto.

When a certain embodiment may be implemented differently, a specific process order may be performed differently from the described order. For example, two consecutively described processes may be performed substantially at the same time or performed in an order opposite to the described order.

FIG. **1** is a plan view schematically illustrating an organic light-emitting display apparatus according to an exemplary embodiment.

Referring to FIG. **1**, the organic light-emitting display apparatus includes a substrate **100** on which a plurality of pixels PX are formed. The substrate **100** may be a low temperature polycrystaline silicon (LTPS) substrate, a glass substrate, or a plastic substrate.

Although not illustrated, exemplary embodiments of the organic light-emitting display apparatus may include an encapsulation substrate that is adhered thereto by sealing. The encapsulation substrate blocks external moisture or air from contact with the plurality of pixels PX, and is disposed to face the substrate **100**. The encapsulation substrate may be a glass substrate, a plastic substrate, or a stainless using steel (SUS) substrate, and the substrate **100** and the encapsulation substrate may be bonded to each other via a sealing member (not shown) that is disposed along edges of the substrate **100** and the encapsulation substrate. According to another exemplary embodiment, a thin film encapsulation film (not shown) may be formed on the substrate **100** instead of the encapsulation substrate to thereby protect the pixels PX. The thin film encapsulation film may have a structure in which a layer formed of an inorganic material, such as a silicon oxide or a silicon nitride, and a layer formed of an

organic material, such as an epoxy or polyimide, are alternately stacked, but is not limited thereto.

The substrate **100** includes a light emission area AA from which light is emitted, and a non-emission area NA disposed in an outer portion adjacent the light emission area AA.

A plurality of pixels PX are disposed in the light emission area AA of the substrate **100**. The pixels PX may be unit pixels including a plurality of subpixels P**1**, P**2**, and P**3** that emit different colors of light. For example, a pixel PX may be a unit pixel that includes a red subpixel P**1**, a green subpixel P**2**, and a blue subpixel P**3**. While a pixel PX including a red subpixel P**1**, a green subpixel P**2**, and a blue subpixel P**3**, is described in the present exemplary embodiment, the pixel PX may further include, for example, a white subpixel.

The non-emission area NA of the substrate **100** may include driving circuit units (not shown) that drive the light emission area AA and a pad electrode PAD that extend from the wiring of the light emission area AA.

Hereinafter, structures of the light emission area AA and the non-emission area NA of the organic light-emitting display apparatus according to embodiments will be described in detail with reference to FIGS. **2**A, **2**B, and **3**.

Referring to FIGS. **2**A, **2**B, and **3**, a plurality of subpixels P**1**, P**2**, and P**3** and a subpixel circuit including a thin film transistor **300**, a capacitor (not shown), and the wiring (not shown) used to drive the plurality of subpixels P**1**, P**2**, and P**3** are formed in the light emission area AA.

The plurality of subpixels P**1**, P**2**, and P**3** are disposed in rows and columns, and the subpixels P**1**, P**2**, and P**3** that each emit light of a certain color, respectively, may be arranged in a first direction (direction D**1**). For example, as illustrated in FIGS. **2**A and **2**B, red subpixels P**1**, green subpixels P**2**, and blue subpixels P**3** may be respectively arranged in rows R**1**, R**2**, and R**3** formed in the first direction D**1**. Although not illustrated, the row R**1** formed by the red subpixels P**1**, the row R**2** formed by the green subpixels P**2**, and the row R**3** formed by the blue subpixels P**3** may be alternately arranged in a second direction (direction D**2**) that is substantially perpendicular to the first direction.

Each of the subpixels P**1**, P**2**, and P**3** formed in the light emission area AA includes a first electrode **210**, emission layers **220**R, **220**G, and **220**B, a common layer **230**, and a second electrode **240**, as illustrated in FIG. **3**.

The first electrode **210** is a pixel electrode and may be patterned to be formed in each of the subpixels P**1**, P**2**, and P**3**. The second electrode **240** is a common electrode and may be formed to correspond to the light emission area AA. As illustrated in FIGS. **2**A, **2**B, and **3**, the second electrode **240** may be smaller than the substrate **100** but larger than the light emission area AA so as to cover the plurality of subpixels P**1**, P**2**, and P**3** formed in the light emission area AA.

The emission layers **220**R, **220**G, and **220**B may include organic materials that respectively emit red light, green light, and blue light for subpixels P**1**, P**2**, and P**3**, respectively. According to an exemplary embodiment, as illustrated in FIG. **2**A, a red emission layer **220**R is formed in the first direction to correspond to the row R**1** of the red subpixels P**1** arranged in the first direction, and a green emission layer **220**G is formed in the first direction to correspond to the row R**2** of the green subpixels **220**G arranged in the first direction, and a blue emission layer **220**B may be formed in the first direction to correspond to the row R**3** of the blue subpixels P**3** arranged in the first direction. According to another exemplary embodiment, as illustrated in FIG. **2**B, red emission layers **220**R may be formed in the first direction to respectively correspond to the red subpixels P**1** arranged in the first direction. Green emission layers **220**G may be formed in the first direction to respectively correspond to the green subpixels P**2** arranged in the first direction, and blue emission layers **220**B may be formed in the first direction to respectively correspond to the blue subpixels P**3** arranged in the first direction. The red emission layers **220**R, the green emission layers **220**G, and the blue emission layers **220**B may be each arranged to form a row in the first direction, and the row of the red emission layers **220**R, the row of the green emission layers **220**G, and the row of the blue emission layers **220**B may be alternately disposed in the second direction.

The common layer **230** may include at least one of a hole transporting layer, a hole injection layer, an electron transport layer, and an electron injection layer. The common layer **230** may be formed to cover a plurality of subpixels P**1**, P**2**, and P**3**. For example, the common layer **230** may be larger than the light emission area AA and smaller than the second electrode **240**, as illustrated in FIGS. **2**A, **2**B, and **3**. The common layer **230** may be formed to cover a plurality of dummy emission layers **221**R, **221**G, and **221**B and **222**R, **222**G, and **222**B included in a dummy area DA.

The non-emission area NA includes a dummy area DA and a contact area CA. The plurality of dummy emission layers **221**R, **221**G, and **221**B and **222**R, **222**G, and **222**B are disposed in the dummy area DA, and the second electrode **240** and a cathode contact portion C-CNT, to which a driving power line **140** is connected, through which power ELVSS (−6V, for example) is supplied to the second electrode **240**, are disposed in the contact area CA.

The plurality of dummy emission layers **221**R, **221**G, and **221**B and **222**R, **222**G, and **222**B formed in the dummy area DA include red dummy emission layers **221**R and **222**R, green dummy emission layers **221**G and **222**G, and blue dummy emission layers **221**B and **222**B. The red, green, and blue dummy emission layers **221**R, **221**G, and **221**B and **222**R, **222**G, and **222**B respectively include the same materials as those of the emission layers **220**R, **220**G, and **220***b* included in the red, blue, and green subpixels P**1**, P**2**, and P**3**. However, unlike the emission layers **220**R, **220**G, and **220**B disposed in the subpixels P**1**, P**2**, and P**3**, the dummy emission layers **221**R, **221**G, and **221**B and **222**R, **222**G, and **222**B do not emit light.

The dummy emission layers **221**R, **221**G, and **221**B and **222**R, **222**G, and **222**B may extend in the first direction to form lines, respectively.

According to an embodiment, as illustrated in FIG. **2**A, the red dummy emission layers **221**R and **222**R, the green dummy emission layers **221**G and **222**G, and the blue dummy emission layers **221**B and **222**B may extend in the first direction so as to form lines, respectively. In this example, the red dummy emission layers **221**R and **222**R extending in the first direction may each form a line L**1**, the green dummy emission layers **221**G and **222**G extending in the first direction may each form a line L**2**, and the blue dummy emission layers **221**B and **222**B extending in the first direction may each form a line L**3**. The lines L**1** of the red dummy emission layers **221**R and **222**R, the lines L**2** of the green dummy emission layers **221**G and **222**G, and the lines L**3** of the blue dummy emission layers **221**B and **222**B may be alternately disposed in the second direction.

According to another embodiment, referring to FIG. **2**B, pieces of red dummy emission layers **221**R and **222**R, pieces of green dummy emission layers **221**G and **222**G, and pieces of blue dummy emission layers **221**B and **222**B may be respectively spaced apart from one another and respectively

arranged in the first direction to form lines. In this example, pieces of the red dummy emission layers **221**R and **222**R may be spaced apart from one another and arranged in a line L**1** formed in the first direction, pieces of the green dummy emission layers **221**G and **222**G may be spaced apart from one another and arranged in a line L**2** formed in the first direction, and pieces of the blue dummy emission layers **221**B and **222**B may be spaced apart from one another and arranged in a line L**3** formed in the first direction. The lines L**1** of the red dummy emission layers **221**R and **222**R, the lines L**2** of the green dummy emission layers **221**G and **222**G, and the lines L**3** of the blue dummy emission layers **221**B and **222**B may be alternately disposed in the second direction.

The red, green, and blue dummy emission layers **221**R, **221**G, and **221**B and **222**R, **222**G, and **222**B of the organic light-emitting display apparatus according to the present embodiment are respectively formed in a deposition operation of the red, green, and blue emission layers **220**R, **220**G, and **220**B included in the subpixels P**1**, P**2**, and P**3**. A deposition mask **10** as illustrated in FIG. **4**A or a deposition mask **10'** as illustrated in FIG. **4**B may be used in a deposition operation as part of manufacturing the display apparatus.

FIG. **4**A is a plan view illustrating a portion of a deposition mask **10** for an organic light-emitting display apparatus according to an embodiment, and FIG. **4**B is a plan view illustrating a portion of a deposition mask **10'** for an organic light-emitting display apparatus according to another embodiment.

Referring to FIGS. **4**A and **4**B, the deposition masks **10** and **10'** according to embodiments include effective opening portions **220** and **220'** formed in a first area A**1** corresponding to the light emission area AA and dummy opening portions **221**, **222**, **221'**, and **222'** formed in a second area A**2** of the non-emission area NA corresponding to the dummy area DA. The deposition masks **10** and **10'** are used to deposit the emission layers **220**R, **220**G, and **220**B in the subpixels P**1**, P**2**, and P**3** included in the light emission area AA, and in the organic light-emitting display apparatus, light is emitted from the emission layers **220**R, **220**G, and **220**B deposited by using the effective opening portions **220** and **220'**. If the deposition masks **10** and **10'** that include only the effective openings are used, it has been found that the deposition masks **10** and **10'** sag due to weight thereof, and it becomes difficult to deposit the emission layers **220**R, **220**G, and **220**B at exact positions. The deposition masks **10** and **10'** sag further as a size of the organic light-emitting display apparatus increases. However, according to the embodiments, the sagging of the deposition masks **10** and **10'** may be prevented or reduced by further including the dummy opening portions.

Referring to FIG. **4**A, the effective opening portions **220** and the dummy opening portions **221** and **222** are slit patterns s**1** extending in the first direction and may be spaced from one another in the second direction.

When an organic light-emitting display apparatus includes red, green, and blue subpixels P**1**, P**2**, and P**3** according to an embodiment, three deposition masks **10** as illustrated in FIG. **4**A may respectively be used to form the red, green, and blue emission layers **220**R, **220**G, and **220**B, **221**R, **221**G, and **221**B, **222**R, **222**G, and **222**B as illustrated in FIG. **2**A.

The red emission layer **220**R and the red dummy emission layers **221**R and **222**R included in the red subpixel P**1** may be formed by using the deposition mask **10** as illustrated in FIG. **4**A. Also, the green emission layer **220**G and the green dummy emission layers **221**G and **222**G included in the green subpixel P**2** may be formed by using the deposition mask **10** as illustrated in FIG. **4**A. Also, the blue emission layer **220**B and the blue dummy emission layers **221**B and **222**B included in the green subpixel P**3** may be formed by using the deposition mask **10** as illustrated in FIG. **4**A.

Although the effective opening portion **220** and the dummy opening portions **221** and **222** of the deposition mask **10** described with reference to FIG. **4**A include the slit patterns s**1**, the embodiments are not limited thereto. According to another embodiment, the effective opening portions **220'** and the dummy opening portions **221'** and **222'** of the deposition mask **10'** may include slot patterns s**2** as illustrated in FIG. **4**B.

Referring to FIG. **4**B, the effective openings **220'** and the dummy openings **221'** and **222'** include a plurality of slot patterns s**2** that are spaced from one another in the first direction, and the effective opening portions **220'** and the dummy openings **221'** and **222'** are spaced from one another in the second direction. Although the slot patterns s**2** of the dummy opening portions **221'** and **222'** have the same shape as the slot patterns s**2** of the effective opening portions **220'** in FIG. **4**B, the embodiments are not limited thereto, and the slot patterns s**2** of the dummy opening portions **221'** and **222'** may be formed in various shapes, for example, in a circular, oval, or polygonal shape.

According to another embodiment, if an organic light-emitting display apparatus includes red, green, and blue subpixels P**1**, P**2**, and P**3**, three sheets of the deposition mask **10'** as illustrated in FIG. **4**B may be used to form each of the red, green, and blue emission layers **220**R, **220**G, and **220**B, **221**R, **221**G, and **221**B, **222**R, **222**G, and **222**B as illustrated in FIG. **2**B.

The red emission layer **220**R and the red dummy emission layers **221**R and **222**R included in the red subpixel P**1** may be formed by using the deposition mask **10'** as illustrated in FIG. **4**B. Also, the green emission layer **220**G and the green dummy emission layers **221**G and **222**G included in the green subpixel P**2** may be formed by using the deposition mask **10'** as illustrated in FIG. **4**B. Likewise, the blue emission layer **220**B and the blue dummy emission layers **221**B and **222**B included in the green subpixel P**3** may be formed by using the deposition mask **10'** as illustrated in FIG. **4**B.

As described above, as the deposition masks **10** and **10'** according to the embodiments include the dummy opening portions **221**, **222**, **221'**, and **222'**, sagging of the deposition masks **10** and **10'** may be prevented or reduced. However, if the dummy opening portions **221**, **222**, **221'**, and **222'** are at relatively large distances, an area of the dummy emission layers **221**R, **221**G, **221**B, **222**R, **222**G, and **222**B formed by the dummy opening portions **221**, **222**, **221'**, and **222'** is increased, and thus the non-emission area NA is also increased.

However, according to the embodiments, a distance d**1** between adjacent dummy opening portions **221**, **222**, **221'**, and **222'** is smaller than a distance d**2** between adjacent effective opening portions **220** and **220'**. Thus, the organic light-emitting display apparatus formed by using the deposition masks **10** and **10'** according to the embodiments may reduce an area of the dummy emission layers **221**R, **221**G, and **221**B, and **222**R, **222**G, and **222**B.

When forming emission layers and dummy emission layers of subpixels by using the deposition masks **10** and **10'** according to the embodiments, the distance d**1** between the dummy emission layers **221**R, **221**G, and **221**B, and **222**R, **222**G, and **222**B having the same color from among the

dummy emission layers **221**R, **222**R, or **221**G, **222**G, or **221**B, **222**B formed in the dummy area DA is smaller than the distance d**2** between the subpixels P**1**, P**2**, and P**3** that are formed in the light emission area AA and emit light of the same color. Accordingly, an area of the dummy emission layers **221**R, **221**G, and **221**B, **222**R, **222**G, and **222**B may be reduced, and an area of the non-emission area NA may be minimized, and a sufficient contact area of the cathode contact portion C-CNT may be provided.

Referring to FIG. **3** again, the second electrode **240** extends up to the non-emission area NA to cover the dummy emission layers **221**R, **221**G, and **221**B, **222**R, **222**G, and **222**B. An end of the second electrode **240** may pass the dummy area DA and extend up to the contact area CA to be electrically connected to a driving voltage line **140** through which power ELVSS is supplied to the second electrode **240**, thereby forming the cathode contact portion C-CNT. For example, the second electrode **240** and the driving voltage line **140** may be electrically connected to each other with a contact layer **215** therebetween.

While FIG. **3** illustrates the dummy emission layers **221**R, **221**G, and **221**B, **222**R, **222**G, and **222**B that have different colors and are spaced apart from one another, the embodiments are not limited thereto. According to another embodiment, dummy emission layers having the same color are disposed at a predetermined distance d**1** while dummy emission layers, **221**G, and **221**B, **222**R, **222**G, and **222**B having different colors may be overlapped with one another. In this case, an area of the dummy area DA may be further reduced.

FIG. **5** is a plan view illustrating a portion of a deposition mask **20** for an organic light-emitting display apparatus according to a comparative example, and FIG. **6** is a cross-sectional view illustrating an organic light-emitting display apparatus according to a comparative example.

As illustrated in FIG. **5**, a distance d**3** between dummy opening portions **22** and **23** formed in a second area A**2'** corresponding to the non-emission area NA in the deposition mask **20** according to the comparative example is equal to a distance d**1** between effective opening portions **21** formed in a first area A**1'** corresponding to a light emission area AA.

In the organic light-emitting display apparatus formed by using the deposition mask **20** according to the comparative example, as the distance d**3** between dummy emission layers **22**R, **23**R, or **22**G, **23**G, or **22**B, **23**B of the same color is relatively broad as illustrated in FIG. **6**, an area of the dummy area DA in the non-emission area NA is relatively large, and an area of the cathode contact portion C-CNT is inevitably reduced. Thus, it is difficult to provide a sufficient contact area between the second electrode **240** and the driving voltage line **140**. To solve this problem, a contact area between the second electrode **240** and the contact layer **215** may be increased but then the area of the non-emission area NA is increased.

In contrast, according to the organic light-emitting display apparatus of the present embodiment, the deposition masks **10** and **10'** are used, in which the distance d**1** between the dummy opening portions **221**, **222**, **221'**, and **222'** is smaller than the distance d**2** between the effective opening portions **220** and **220'**. As a result, an area of the dummy area DA may be reduced, a cathode contact portion C-CNT having a sufficient area may be provided, and the non-emission area NA may be reduced.

As described above, according to the one or more of the above exemplary embodiments, a cathode contact portion having a sufficient area may be provided in an organic light-emitting display apparatus and a deposition mask for the organic light-emitting display apparatus. Furthermore, an area of a non-emission area (i.e., the bezel area) may be reduced. Of course, the scope of the inventive concept is not restricted by this effect.

Although certain exemplary embodiments and implementations have been described herein, other embodiments and modifications will be apparent from this description. Accordingly, the inventive concept is not limited to such embodiments, but rather to the broader scope of the presented claims and various obvious modifications and equivalent arrangements.

What is claimed is:

1. An organic light-emitting display apparatus comprising:

a substrate comprising a light emission area and a non-emission area disposed in an outer portion adjacent the light emission area;

a plurality of subpixels disposed in the light emission area of the substrate and comprising a first electrode, an emission layer, and a second electrode, wherein the plurality of subpixels are configured to respectively emit light of different colors; and

a plurality of dummy emission layers that are disposed in the non-emission area of the substrate and are of different colors,

wherein a first distance between adjacent first dummy emission layers of a first color with a second dummy emission layer therebetween, from among the plurality of dummy emission layers is smaller than a second distance between adjacent first subpixels that emit light of the first color with a second subpixel therebetween, from among the plurality of subpixels, and the second dummy emission layer has a second color different from the first color and the second subpixel emits light of the second color.

2. The organic light-emitting display apparatus of claim **1**, wherein the plurality of subpixels comprise:

a first row arranged in a first direction and comprising a plurality of subpixels that emit light of the first color; and

a second row arranged in the first direction, the second row disposed adjacent the first row and comprising a plurality of subpixels that emit light of the first color,

wherein the second row is spaced apart from the first row by the second distance in a second direction that is substantially perpendicular to the first direction.

3. The organic light-emitting display apparatus of claim **2**, further comprising a third row arranged in the first direction and disposed between the first row and the second row, the third row comprising a plurality of subpixels that emit light of a second color that is different from the first color.

4. The organic light-emitting display apparatus of claim **1**, wherein the plurality of dummy emission layers comprise:

a first line formed in a first direction and comprising at least one dummy emission layer having the first color; and

a second line formed in the first direction, the second line disposed adjacent the first line and comprising at least one dummy emission layer having the first color,

wherein the second line is spaced apart from the first line by the first distance in a second direction that is substantially perpendicular to the first direction.

5. The organic light-emitting display apparatus of claim **4**, further comprising a third line formed in the first direction, the third line disposed between the first line and the second line and comprising a dummy emission layer of a second color different from the first color.

6. The organic light-emitting display apparatus of claim 1, wherein the second electrode extends over a portion of the non-emission area to cover the plurality of dummy emission layers.

7. The organic light-emitting display apparatus of claim 1, further comprising:

a cathode contact portion; and

a driving power line,

wherein an end portion of the second electrode and the driving power line are electrically connected to the cathode contact portion, and

wherein the driving power line is configured to apply power to the second electrode.

8. The organic light-emitting display apparatus of claim 7, wherein the cathode contact portion further comprises a contact layer,

wherein the contact layer contacts the second electrode and the driving power line, and

wherein the contact layer electrically connects the second electrode and the driving power line.

9. The organic light-emitting display apparatus of claim 1, further comprising a common layer interposed between the first electrode and the second electrode.

10. The organic light-emitting display apparatus of claim 9, wherein the common layer is larger than the light emission area and is smaller than the second electrode.

11. A deposition mask for manufacturing an organic light-emitting display apparatus, the deposition mask comprising:

a plurality of effective opening portions that correspond to a plurality of first subpixel regions of a light emission area and are disposed in parallel to one another; and

a plurality of dummy opening portions that correspond to a non-emission area included in an outer portion adjacent the light emission area and that are disposed in parallel to one another,

wherein a first distance between adjacent dummy opening portions from among the dummy opening portions is smaller than a second distance between adjacent effective opening portions from among the effective opening portions, and

the deposition mask covers a plurality of second subpixel regions between the adjacent effective opening portions.

12. The deposition mask of claim 11, wherein each of the adjacent effective opening portions includes a slit pattern extending in a first direction, and

the adjacent effective opening portions are spaced apart from one another by the second distance in a second direction that is substantially perpendicular to the first direction.

13. The deposition mask of claim 11, wherein each of the adjacent effective opening portions includes a plurality of slot patterns arranged a first direction, and

the adjacent effective opening portions are spaced apart from one another by the second distance in a second direction that is substantially perpendicular to the first direction.

14. The deposition mask of claim 11, wherein each of the adjacent dummy opening portions includes a slit pattern extending in a first direction, and

the adjacent dummy opening portions are spaced apart from one another by the first distance in a second direction that is substantially perpendicular to the first direction.

15. The deposition mask of claim 11, wherein each of the adjacent dummy opening portions includes a plurality of slot patterns arranged in a first direction, and

the adjacent dummy opening portions are spaced apart from one another by the first distance in a second direction that is substantially perpendicular to the first direction.

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